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Spatial and space-time correlations in the U.S. human capital accumulation processes

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Abstract

Our study examines the specific relationship between poverty and educational attainment as a measure to access to knowledge in a particular and well-defined socio-economic context as the multifaceted United States. We use data about advanced levels of education over the last decade, considering all the American States, which play a key role in both past and recent choices in the field of education and training, both for welfare and distribution of income and wealth. U.S. is a complex country system which has paid particular attention to national human capital accumulation, with heavy investments in time, opening the door to the one of the most advanced economy in the world, nowadays almost certainly the most advanced. However, this is also a nation full of contrasts, between ethnic groups, religious minorities and different social classes. Spatial and temporal character of our empirical analysis allows to observe the different situations which emerge in the various States in order to represent an outline of the national context and to examine specifically these unique and interesting areas.

Keywords: human capital, poverty condition, spatial-temporal analysis, discriminant analysis. JEL classification: C22, C23, C53, H52, I21, I30, I31.

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1. Foreword and basic remarks

The aim of this analysis is to look at the U.S. socio-economic context related to human capital accumulation in terms of different rate of school enrollment and educational attainment, and to poverty, particular among children. In the country observed there are particular conditions of poverty for children than many other Western perspectives. Looking at the UNICEF data on child poverty (2005), it is possible to remark a high presence of American children below the national poverty line. This create a situation of relative poverty[1] affecting 21,9% of the population, among the richest countries exceeded in a negative way only by Mexico (27,7%). From *U.S. Census Bureau* data, in 2009 the 20,7% of those people under 18 years was in poverty, a rate that drops to 12,9% for the population from 18 to 64 years, and to 8,9% for 65 years and older. Some contemporary surveys by World Bank (2009a, 2009b) describe U.S. school participation at primary level, lower than many other Western countries, and as we know from the specific recent literature (Huston, 1991; Solley, 2005; Krugman and Wells, 2009; Narayan *et al.* 2009a, 2009b; Dudwick *et*

[1] Households with income below 50 per cent of the national median income (UNICEF, 2005).

1877–0428
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al., 2009) deprivations in the early years of studies leads to rear barriers towards the continuation of the studies themselves. This condition increases the risk of falling below the poverty line, or have problems such as social exclusion, with the risk of not finding steady employment or do not integrate fully into society. Many studies have found that there is a high risk of educational underachievement for children who are from low-income housing circumstances. This often is a process that begins in primary school and continues to the next grades. In the U.S. educational system, these children are at a higher risk than many others for retention in their grade, special placements during the school's hours and even not completing their high school education. There are indeed several explanations for why students tend to drop out of school. For children with low resources, the risk factors are similar to excuses such as juvenile delinquency rates, higher levels of teenage pregnancy, and the economic dependency upon their low income parent or parents. Families and society who submit low levels of investment in the education and development of less fortunate children end up with less favorable results for the children who see a life of parental employment reduction and low wages. Higher rates of early childbearing with all the connected risks to family, health and well-being are majorly important issues to address since education from preschool to high school are both identifiably meaningful in a life (Sen, 1981, 1999; Huston, 1991). Poverty often drastically affects children's success in school. A child's home activities and preferences must align with the world and in the cases that they do not these students are at a disadvantage in the school and most importantly the classroom. Therefore, it is safe to state that children who live at or below the poverty level will have far less success educationally than children who live above the poverty line. Poor children have a great deal less healthcare and this ultimately results in many absences from the academic year. Additionally, poor children are much more likely to suffer from hunger, fatigue, irritability, headaches, ear infections, flu, and colds. These illnesses could potentially restrict a child or student's focus and concentration (Solley, 2005). Since the '90s, U.S. have started specific social policies, which have affected both the conditions of poverty that the possibility of access to education. This was due to a period of general economic prosperity. Policies in support of vulnerable groups has led to a reduction, in the '90s, of 2,4% of the poverty level previously described (always with reference to the threshold 50% of median income). A positive result if compared with other advanced economies such as Italy and Germany, among others, where there has been an increase respectively of 2,6% and 2,7% (UNICEF, 2005). U.S. is a federation characterized by discrete autonomy granted to individual member States, which over time have led however to economic and social differences. For example, there are differences between the level of unemployment rate in Michigan (8,4%) and that of South Dakota (3%), the per capita personal income of Connecticut ($ 56,272) and Mississippi ($ 30,399), and finally person below poverty line are 21,2% in Mississippi and 7,6% in New Hampshire (U.S. Census[2] data, 2008). The Southern States are in a more difficult economic adversity, in a country system deeply affected by the general slowdown of the global economy. These differences lead us to specify our investigation, which considers the data concerning all U.S. States, with a special attention at the relation between poverty and human capital accumulation processes, focusing in particular to the process of education, taking account of the key role played by welfare policies, and redistribution of income and wealth among households. In U.S. both politic and private attention on education and human capital accumulation led to the consolidation of a highly advanced economy. Of course this would not have been possible without additional and fundamental resources, tangible and intangible, remaining fundamental the desire expressed by politicians and entrepreneurs to seek workers characterized by high productivity in a very highly competitive context. Actually education and training activities are considered a strength for Western economies and especially for developing countries, and it is therefore essential to create virtuous processes in order to increase the average education, lifelong learning education, and the conscious use of new ICTs, and thus ensure the long-term economic growth. The state of the economy and the accumulation processes affecting the level of human capital are extremely interconnected, and necessarily interdependent. Only if all these resources, also defined immaterial, will be available and work jointly, it will be possible to struggle effectively, among other, the problems of poverty (see for example Jaminson *et al.*, 2006). The economic conditions strongly influence the decisions of school attendance (see among others Brown and Park, 2002), especially in poorer countries where the offspring is used as a typical work resource (for example, Cameron, 2009), and in any case everywhere the households cannot meet the cost of education, in the absence of specific grants to support families. This condition can establish a vicious cycle of passing the levels of poverty across generations, and if it has a

[2] Retrieved from: http://www.census.gov/compendia/statab/rankings.html (October, 28th 2010).

meaning more severe in poor countries, in a rich nation as the U.S. could lead to a lower level of intergenerational mobility (Maoz and Moav, 1999; Sawhill, 2006; Sawhill and Morton, 2007). In addition, it is also essential to note that the problems caused by the economic deprivation on human capital child development are also found in cognitive and behavioral fields (Duncan *et al.*, 1994). Finally, even in Western countries there are many reasons for early school leaving, or non-attendance, (Eckstein and Wolpin, 1999), particularly for those populations most vulnerable, which in a country as the U.S. consist of many ethnic minorities (Entwisle and Alexander, 1993). Nevertheless what is relevant to this study is that deprivation during the early school stages leads to drop-out or study career problems, and this leads also to a pattern with a low level of human capital increase. In an economically advanced society, knowledge and skills of a person, in the form of education, is an even more important determinant of economic growth than physical capital, and they are the only resources to ensure good living conditions, and more generally, to contribute to the development of civilization as a whole. A key body of literature relates to the rates of return for the individual (and for society in general) of investment in human capital, in the form of education and training. Much of this research draws on the seminal work by Becker (1964), Mincer (1974) and many others. This body of work is founded on a microeconomic approach. Nevertheless the results have important macroeconomic implications. They highlight the strong links observed between education, productivity and output levels. Although some have questioned the direction of causality and argued that much education simply acts as a screening device to help employers to identify more able individuals, the general consensus seems to be that education does result in higher individual productivity and earnings (see also Barro, 1997, 2000; Aghion and Bolton, 1997; Acemoglu, 1998). The relationships developing between poverty during the first years of school and the problems which follow, studied for the U.S. among others by Rank and Hirschl (1999), is viewed as a cause of social exclusion, persistent poverty and difficulties in integrating into the community. From the just mentioned work it is possible to note that in recent decades children have been one of the most affected social group by the problem of poverty and education activities, in particular those children belonging to ethnic minorities, as many of the Blacks, which in U.S. are considered highly at risk. The research works by Korenman *et al.* (1995) refers to the U.S. youth poverty condition, from the data of the *National Longitudinal Survey of Youth* (1979), and confirm the cognitive barriers that years of deprivation have a negative impact on children's learning processes. Blau (1999) and Chevalier *et al.* (2005) analyze the relationship between parental income and the children's cognitive, social, and emotional development, which results in one of the causes of the transfer of income between generations. Here a key role is played by parents' investment on the human capital of children, without forgetting the importance of public policies, education and services provided to a welfare perspective. Investments in human capital, both in the form of health and education, is needed for economic growth. Deworming children costs about fifty cents per child per year and reduces non-attendance from anemia, illness and malnutrition and is only a twenty-fifth cents as expensive to increase school attendance as by constructing schools (Kremer and Miguel, 2004).

2. Analysis of human capital accumulation on poverty condition perspectives

Our investigation is focused on the U.S. socio-economic context, one of the richest and most advanced economy in the world, but where there are also particular social conflicts and a deep inequality. Of course, the relationship between the people economic situation and their ability and willingness to attend school is complex and the reasons for leaving vary at each different school levels. In Western countries there are forms of social protection and assistance giving help in many cases in order to support in attending school, at least in the first stages. For this reason it is more interesting to analyze the years of high school, where students have a certain age, and therefore the relatively capacity and possibility to choose different paths of life. In more detail we refer to the range of ages ranging from 14 to 18 years, when it is easier to deviate from the education path and start a low-skilled job. The American economic hardships affect different ethnic groups, genders, and have strong effects particularly on the weaker and at risk of poverty social groups (as well observed by Warren and Cataldi, 2006; Astone and Upchurch, 1994). The compulsory education in U.S. varies from State to State, however is precisely in the range of ages we consider in which the various States establish limits to school drop-out, specifically in the subrange 16-18 years, even if in some States local laws prescribe rigorous conditions under which children may be exempted from few

years of compulsory attendance[3]. For these reasons we have chosen to consider data on the levels of school drop-out by State, provided by the *National Center for Education Statistics* (2010) at the U.S. Department of Education. These data should be compared with indicators of poverty, available from the U.S. Census Bureau (2010), for the purpose to study if there is an explanatory report among these two phenomenon. We proceed to calculate the average level (years 2001-2008), for each American State, of school drop-outs from 9th to 12th grades of education levels. The following analysis concerns the percentage of poverty found in the American states, over the period 2001-2008, in correlation with the trend of school dropping out of each State. The first approach is to verify the relationship between the two variables and as mentioned for this analysis we consider the drop-out rates in schools for students attending the high school years, from 9th to 12th grade. The indicator of drop-outs has been reconstructed by comparing its absolute value, to that of its population of each state for each year considered. First we observe the relationships of various levels of drop-out, with poverty levels, in a cross-country analysis based on the U.S. States. The drop-out indicator used is reconstructed assuming a value of synthesis of the 8-year period. The same procedure is performed to detect the average poverty rate in these eight years.

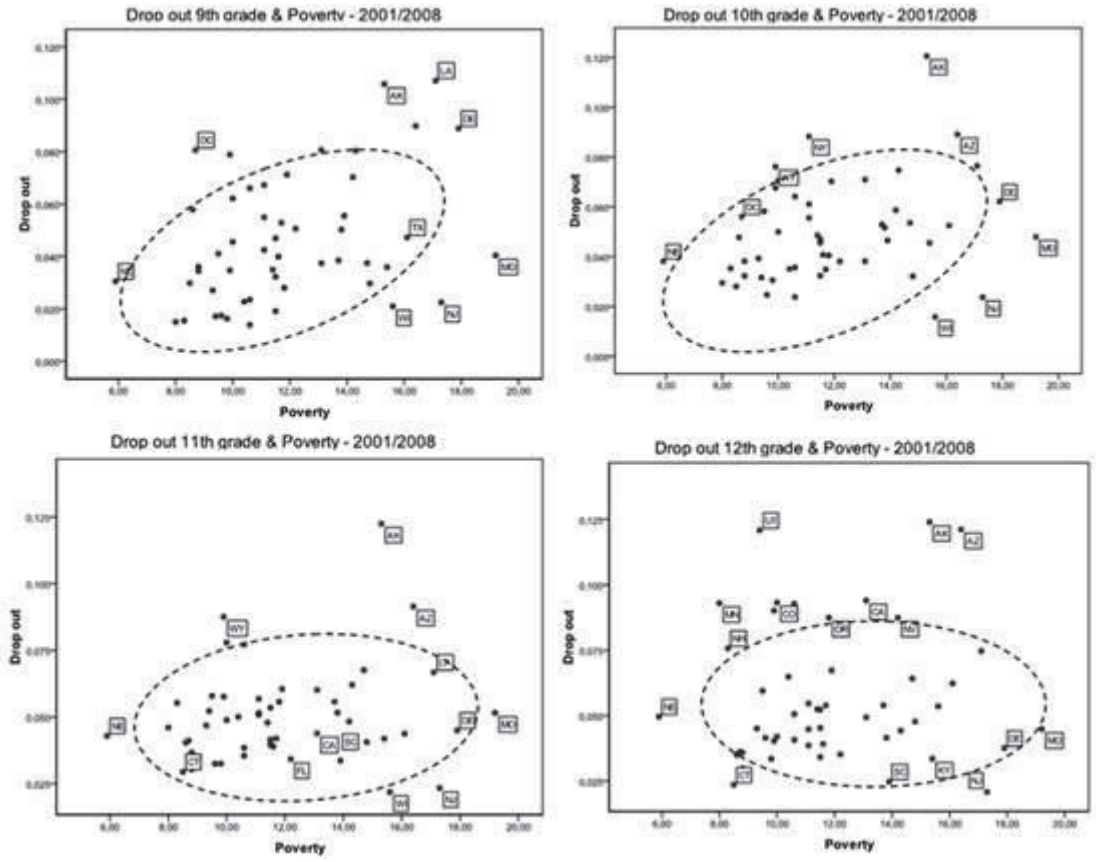

Fig. 1 - Percentage of school drop-outs in 9th, 10th, 11th e 12th grade, compared to the percentage of poverty in each U.S. States, average 2001-2008 (World Bank and National Center for Education Statistics data, 2010).

From the first Figure, top left, we see how the level of drop-outs tend to grow at a higher average levels of poverty. The States most affected by this negative phenomenon are those in the chart at the top right, Louisiana, Delaware, and Alaska, conversely a more favorable situation for New Hampshire. The same phenomenon is seen in the second graph, top right, but in this case it is interesting to highlight the situation of Delaware, Missouri, New Jersey and

[3] Retrieved from: http://nces.ed.gov/programs/digest/d08/tables/dt08_165.asp (November, 12th 2010).

Wisconsin, which maintain low levels of school leaving despite an economic condition worse than in other States. In the 11th grade (chart at the bottom left) the evolution of the phenomenon is more constant, showing similar levels for the whole United States. Similar situation for the last graph (12th grade, bottom right) in which students are closer to the achievement of the qualification, and tend to maintain the school frequency. It is necessary to say that in the latter two school grades the levels of school drop-out are higher than the previous grades, and it is interesting to note that in this students' age the economic condition affect less on the crucial decision of leaving school early. Indeed, States with a different economic situations, such as Alaska, California, Utah, Colorado, and Arizona, show higher rates of drop-out. For further analysis we use maps of the U.S. representing the spatial distribution of education levels. We appreciate from the above analysis that the problem of poverty afflict many Southern States, and the following map (figure 2) shows how the issue of the education level is widespread, both socially and economically, and it has an effect on the quality of national human capital.

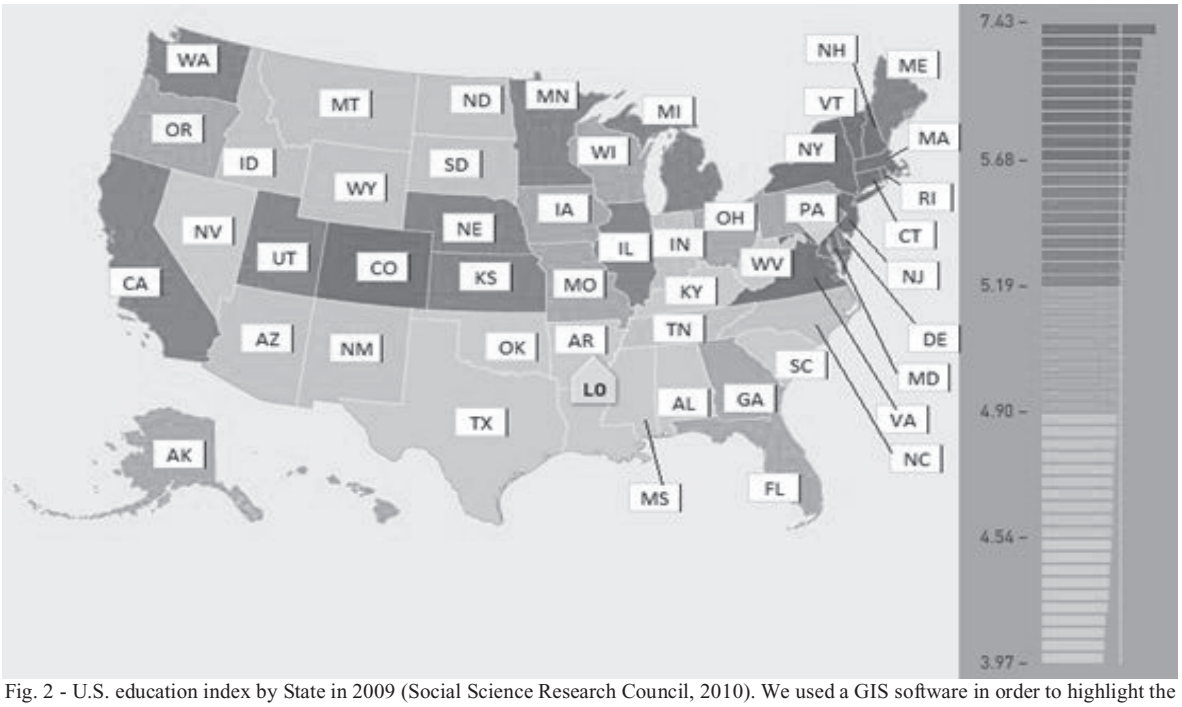

Fig. 2 - U.S. education index by State in 2009 (Social Science Research Council, 2010). We used a GIS software in order to highlight the differences between the education indexes of States.

The map in Figure 2 shows the education index in the American States considering every types of people and both genders. This indicator falls in the American Human Development Index. The education index is defined as access to knowledge and is measured using two sub-indicators: school enrollment for the population age 3 and older, and educational degree attainment for the population 25years and older. A one-third weight is applied to the enrollment indicator and a two-thirds weight is applied to the degree attainment indicator. Both indicators are from the American Community Survey, U.S. Census Bureau. From the Figure 2 it is also clear that the District of Columbia, Massachusetts and Connecticut represent the highest percentage of education index together with Maryland, New Jersey, New Hampshire, Colorado, Vermont, New York, Rhode Island e Virginia, mainly due to a high percentage of students who have obtained bachelors degree. In contrast, Arkansas, West Virginia, Louisiana, Nevada, Alabama, Kentucky, Mississippi, Texas, South Carolina and Oklahoma reveal the lowest percentage of population who has attained a bachelor degree and has a title below to high school. The remaining States are distributed in the Central area with the proportion of people who have completed high school.

Tab. 1 - School drop-outs average percentage of the American States (years 2001-2008).

State	drop-out	State	drop-out	State	drop-out	State	drop-out
NJ	0,02	MO	0,04	KS	0,05	MI	0,07
CT	0,02	NC	0,04	MT	0,05	NH	0,08
SC	0,02	NM	0,04	NE	0,05	CA	0,09
AL	0,03	NY	0,04	OH	0,05	CO	0,09
KY	0,03	OK	0,04	SD	0,05	MN	0,09
MS	0,03	PA	0,04	TN	0,05	NV	0,09
ND	0,03	RI	0,04	VT	0,05	OR	0,09
DC	0,04	VA	0,04	WI	0,05	WA	0,09
DE	0,04	WV	0,04	AR	0,06	WY	0,09
FL	0,04	GA	0,05	HI	0,06	AK	0,12
IN	0,04	IA	0,05	ME	0,06	UT	0,12
MA	0,04	ID	0,05	TX	0,06	AZ	0,12
MD	0,04	IL	0,05	LA	0,07		

Table 1 shows a minimum value of drop-out for States such as Connecticut, New Jersey and South Carolina with an average value of 0,02%. The maximum is found in States such as Alaska, Arizona and Utah with an average value of 0,12%. The variability found for this phenomenon is very low. This result indicates that most part of the States has concentrated on a percentage of 0,05%. The index of symmetry introduces an asymmetry of the analyzed distribution for values higher than the average value, while the kurtosis value is quite low. This result explains a normal distribution of the phenomenon. We note the differences arising in the analysis of the percentage of drop-out related to poverty. The fundamental divergence regards the New Hampshire because we observe a low percentage of poverty but a higher average value about drop-out. Finally, considering more decimal values, we identify the New Jersey as the country with the lowest percentage of drop-outs and Arizona as the one with the highest percentage of it. For this reason we analyze the time series from 2001 until 2008 of these two limiting cases. The trend of school drop-out for New Jersey is decreasing over time with a spike in 2001 and a continuing descending rates until 2004 first and 2008 afterwards. On the other hand, we note for Arizona a growing trend over time: in 2007, it is clear that the spike stood at nearly 0.15% for that State. Thus the following analysis refers to the estimated linear models known in economics and statistical literature in order to identify and then choose the model that best approximates the phenomenon of drop-out in the current series for New Jersey and Arizona.

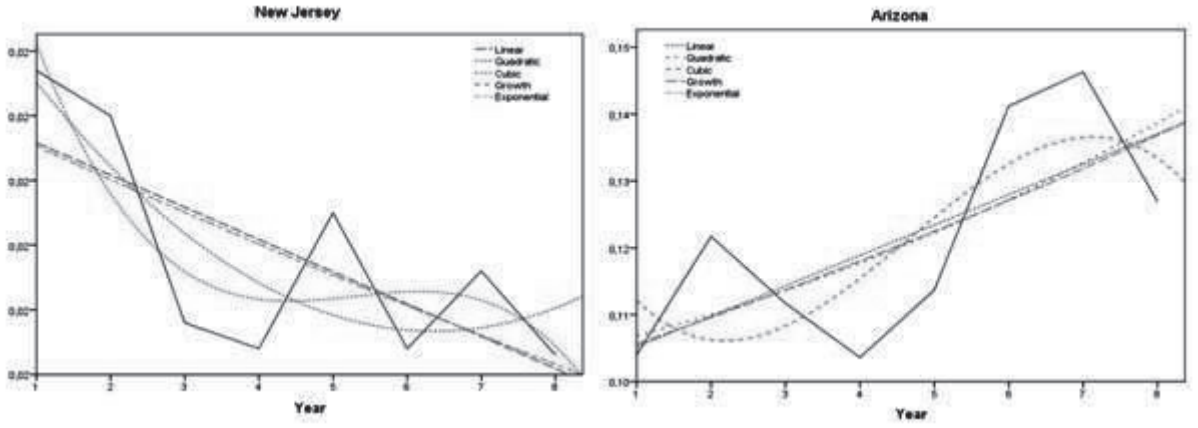

Fig. 3 - Models for the study of school drop-out in New Jersey and Arizona from 2001 to 2008.

In figure 3 we show the following models: linear, quadratic, cubic, exponential and growth for New Jersey and Arizona for the years ranging from 2001 to 2008. In both cases, the cubic type model appears with a better fitting from observed to theoretical data. The cubic model considered for this analysis is the following:

$$Drop\,out = \alpha + \beta t + \gamma t^2 + \delta t^3 + \varepsilon_t \qquad (1)$$

In the formula α is the constant of the cubic model; β, γ and δ are the estimates parameters of the cubic model; t is the temporal variable and we have three fundamental variations in the phenomenon of drop-out; ε_t is the residual variable. In the cubic model we consider three estimates parameters and we consider the model in correlation with the temporal variable. We note three fundamental variations in the evolution of the phenomenon of school drop-out. Here we report the parameters that were estimated for each type of model in the two series considered:

Tab. 2 - Parameter estimates.

New Jersey	model summary					parameter estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,499	5,978	1	6	,050	,023	,000		
Quadratic	,643	4,503	2	5	,076	,025	-,002	,000	
Cubic	**,733**	3,660	3	4	,121	,028	-,005	,001	,000
Growth	,490	5,762	1	6	,053	-3,770	-,023		
Exponential	,490	5,762	1	6	,053	,023	-,023		
Arizona	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,478	5,502	1	6	,057	,101	,005		
Quadratic	,483	2,339	2	5	,192	,104	,002	,000	
Cubic	**,566**	1,742	3	4	,296	,129	-,023	,007	-,001
Growth	,483	5,607	1	6	,056	-2,285	,037		
Exponential	,483	5,607	1	6	,056	,102	,037		

The fitting of the cubic model reveals the best values compared to those of other models. In New Jersey, we have a fitting equal to 0,733, while in Arizona is equal to 0,566. The Fisher statistics is calculated to determine the significance of the estimated parameters for each model and it is significant for each model analyzed with a margin of error between 0,05 and 0,10. Hence the cubic model is the one that has more correct features about the phenomenon under observation for the two American States considered. This type of phenomenon shows a fluctuating over time which therefore varies considerably. Consequently, the State of Arizona has a less than optimal performance of school drop-out, as being the phenomenon continues to grow could lead to a breakdown in the social balance of the state.

3. Concluding remarks

The overall conclusion from this work is that the impact of investments in education and training on national economic growth is positive and significant, as they contrasted directly critical economic and social issues over the territory. Education is certainly a key determinant of economic growth for both developed and developing countries and its impact is different but extremely necessary in every local context. This contribution examines the relationship between economic conditions in various American States and their citizens' school attendance. It has noted that the socio-economic situation in the U.S. is diversified, hence there are contexts in which the problem of poverty can have serious negative effects as well on the processes of growth and economic development. It is

recognized by the economic literature that quality of human capital is a key strategic lever in an advanced economy as the U.S., which integrates with the labor market and interfaces with functions that require high productivity and use of modern technology ICT. Through the study of specific data regarding the levels of school drop-out and poverty for each State considered we find out a strong relationship between the cited phenomena, in a country in which although there is widespread attention to education, there are still strong contrasts and critical situations related to ethnic and religious minorities, and more generally to all subjects in a circumstance of relative poverty. In particular, evidence suggests a very significant return for both the individual and society as a whole from investments in higher education in developed countries. Computed social rates of return vary between countries and over different time periods, but most are positive and they provide justification for government continuing investment in higher education. However, there are emerging concerns of graduate overcrowding, as the percentage of graduates in the labour market continues to increase, and this trend needs careful monitoring to ensure that social returns are not diminished through over qualification. For this reason, we used data about the attendance of the typical years of American high school, in which given the significant age is more likely to leave school early, and we observe a direct relationship between the increase of poverty and school drop-out in the first years and an increase in average values with the increasing of abandonment at various school levels. Then we examine specifically the two States which occupy the first and last place in the ranking prepared by us on the basis of the findings of the variable drop-out, New Jersey and Arizona, the first having a value of the abandonment lower and improving, and a situation quite opposite for the second State. It is therefore noted, as part of a broader scientific stream devoted to the study of human capital in economic systems, that education is influenced by economic and social context, and in turn constitutes an essential intangible asset to boost economies, for example due to the recent economic crisis that began in 2007-2008 (Stiglitz, 2010). It seems clear that governments should provide investment in education and every incentive to companies, either through tax allowances or direct grants, as well as through reforms to institutional structures, etc., to encourage them to increase their investment in education and training. Such activities can provide strong spill-over effects for the entire society.

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